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Role of the Physical Therapist in Reducing Postoperative Complications in Type 2 Diabetics

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Abstract

This article examines current research on the topic of reducing postoperative complications in patients with type 2 diabetes mellitus. Type 2 diabetes is a metabolic condition with rapidly increasing prevalence. Patients with type 2 diabetes are twice as likely to undergo surgery for comorbid conditions compared to individuals without the disease (Zantidis, Iliadis, & Didangelos, 2011). Aside from higher instances of surgical intervention, type 2 diabetic patients experience a higher rate of perioperative complications compared to individuals without the disease (Holt, 2012). Concurrent conditions such as peripheral neuropathy and hyperglycemia put diabetic patients at a higher risk of surgical complications and even mortality (Chuah, Papamargaritis, Pillai, Krishnamoorthy, & le Roux, 2013). Much research has been done exploring the various complications associated with surgical intervention in type 2 diabetics. However, there has yet to be a universally accepted approach to reducing such complications (Chuah et al., 2013). The purpose of this study is to examine current research to create a comprehensive policy that health care professionals should follow when treating type 2 diabetic surgical patients in order to reduce instances of perioperative complications. Two physical therapists were also interviewed to provide qualitative data on what is currently being done in the field to manage type 2 diabetic complications.

Keywords: Type 2 Diabetes Complications, Postoperative Complications

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Introduction

Type 2 diabetes is an endocrine disorder characterized by a developed resistance to the hormone insulin. Since insulin is primarily responsible for the uptake of glucose into the cells of the body, this insulin resistance can cause dangerously high blood glucose levels.

Type 2 diabetes is quickly rising in its prevalence. The 2014 National Diabetes Statistics Report states that 29.1 million people in the United States are living with diabetes; approximately 8.1 million of these cases are undiagnosed (Center for Disease Control [CDC], 2014). The Center for Disease control also reports that 90-95% of diagnosed diabetic cases are categorized as type 2 (CDC, 2014).

The presence of type 2 diabetes is often accompanied by many complications. Hyperglycemia, a state of higher than normal blood glucose levels, can lead to a wide variety of chronic complications. Long-term diabetic complications can be categorized as macrovascular and microvascular. Macrovascular diseases include cardiovascular disease and peripheral vascular disease. The more common form of long-term diabetic complications, however, is the microvascular subset (Chuah, Papamargaritis, Pillai, Krishnamoorthy, & le Roux, 2013). These diseases include peripheral neuropathy, retinopathy, and nephropathy. Such conditions can be very debilitating and even life threatening.

The complications and comorbid conditions that are seen in many type 2 diabetics frequently require surgical intervention. Fifty percent of diabetic patients will undergo a surgical procedure in their lifetime (Zantidis, Iliadis, & Didangelos, 2011). The presence of type 2 diabetes greatly increases an individual's likelihood of experiencing perioperative complications.

Postoperative Stress Response

The high rate of complications experienced by surgical type 2 diabetic patients is largely due to the body's postoperative response to stress. The trauma of surgery initiates the release of hormones such as epinephrine, norepinephrine, cortisol, growth hormone, and glucagon. The purpose of this response is to provide the body with metabolic energy needed heal and manage pain (Holt, 2009). The increased secretion of epinephrine and glucagon causes a rise in blood glucose levels in an attempt to mobilize energy stores (Holt, 2012). In the diabetic population, this mechanism further impairs glucose regulation.

Insulin utilization is also affected in the postoperative stress response. After the trauma of surgery, the body both decreases insulin secretion and increases insulin resistance (Dogago-Jack & Alberti, 2002). Surgery reduces the ability of pancreatic beta cells to secrete insulin (Holt, 2014). Without proper insulin function, the body is unable to store excess circulating glucose.

The glucose releasing effects of glucagon and epinephrine combined with impaired insulin functioning cause the body to enter a state of hyperglycemia. This hyperglycemic state can have many detrimental effects in the type 2 diabetic patient. According to Holt, hyperglycemia can increase the risk of perioperative infection through compromised phagocytosis, delayed chemotaxis and reduced bacteriocidal capacity (2014). Hyperglycemia

can also negatively affect collagen formation which can lead to a decrease in wound healing (Holt, 2014).

Type 2 Diabetes Complications

Type 2 diabetic patients experience many postoperative complications related to preexisting concurrent conditions. Patients with diabetic peripheral neuropathy are twice as likely to have mobility limitations (Tutle, Hastings, & Meuller, 2012). Peripheral neuropathy can lead to increased muscular atrophy as well as increased intramuscular adipose tissue (Tutle et al., 2012). These factors, combined with postoperative pain and fatigue, can make initial ambulation in the type 2 diabetic patient more difficult. Peripheral vascular disease is another common culprit in diabetic postoperative complications by decreasing blood flow to the wounded area. This decrease in blood flow is linked to higher rates of infection and poor wound healing (Metchick, Petit, & Inzucchi, 2002). Bedsores and pressure ulcers can result from poor circulation in patients with peripheral vascular disease.

Other postoperative complications linked to the presence of type 2 diabetes include respiratory infections, myocardial infarction, admission into an intensive care unit, and increased length of stay (Chuah et al., 2013). These complications have detrimental effects on the health and well-being of the patient as they can increase pain and decrease functionality. For these reasons, type 2 diabetic complications can lead to a decrease in overall quality of life.

There are many postoperative complications associated with type 2 diabetes. Prevention of such complications should be high priority when treating a surgical type 2 diabetic. Despite the high need for a postoperative plan of care, a universally accepted approach has not yet been identified (Chuah et al., 2013). A multifactorial method should be used to prevent foreseeable

complications. Doing so requires coordinated efforts of the patient's primary care physician, surgical team, nursing staff, and physical therapists. Although pharmacologic therapy and diet are necessary components in reducing type 2 diabetic complications, many complications can be managed through activity-related interventions. Physical therapists should play an active role in the care of a postoperative type 2 diabetic patient. These physical therapy-related interventions should begin immediately after surgery.

Lower Leg Ulceration

Decreasing instances of leg and foot ulcers should be a high priority objective when treating a postoperative type 2 diabetic. Johnson and Rogers state that 15-25% of diabetic patients will develop a foot ulcer in their lifetime compared to 1% of the entire adult population (2011). This statistic shows just how susceptible diabetic patients are to developing an ulcer. Aside from the effects that leg and foot ulcers have on the diabetic patient, they also apply a great financial burden to the healthcare industry. Medical costs of diabetics are on average 2.4 times greater than the general population; however, the presence of a chronic lower extremity wound raises this value to 5.4 times greater (Johnson & Rogers, 2011). Interventions to reduce rates of lower leg ulceration should include frequent repositioning, use of compression stockings in appropriate subsets of patients, and regular skin assessments of the legs and feet.

Bedridden type 2 diabetic patients should be frequently repositioned in order to reduce instances of skin breakdown and subsequent ulceration. During the immediate postoperative period, the patient frequently spends many, if not all, of their time in bed. Pressure transmitted from a bed or chair can cause deformation of soft tissue which can ultimately lead to ischemia of the affected area (Miles, Nowicki, & Fulbrook, 2013). Repositioning techniques aim to reduce this pressure therefore reducing occurrences of pressure injuries. Miles et al. also reports that

this repositioning should take place every two hours (2013). Healthcare professionals should reposition bedridden patients in a way that is both comfortable for the patient and reduces pressure to areas that frequently come in contact with the bed. The heels should be lifted off of the bed through use of pillows or foam pads to offload pressure (Miles et al., 2013). Another area of consideration when repositioning postoperative patients is medical device location. It is extremely common for surgical patients to have IV tubing, drainage devices, or foley catheters present in the bed. Healthcare professionals should ensure that the patient is not laying on these devices as they can exert pressure onto the body (Miles et al., 2013). Physical therapists of postoperative type 2 diabetics should play an active role in the repositioning of patients. Coordinated efforts with the nursing staff should be made so that optimal positions for each patient can be determined as well as positions that should be avoided.

In addition to regular turning, compression stockings can be an effective measure in reducing lower leg and foot ulcers in type 2 diabetics only if they do not have a history of peripheral neuropathy or peripheral vascular disease (Johnson & Rogers, 2011). Patients with peripheral neuropathy or peripheral vascular disease experience reduced circulation to the extremities that can be exacerbated with the use of compression therapy. However, the use of compression stockings can help prevent lower leg ulceration in diabetic patients without the previously stated conditions. One factor contributing to the formation of lower leg ulceration is slow venous return (Cullum, Nelson, Fletcher, & Sheldon, 2001). This is especially prevalent in postoperative patients that spend much of their day in the supine position. Graduated compression can have many effects on the leg including reduction in cross sectional area, increase in velocity of venous blood flow, reduction in venous wall distention, and improved valve functioning (Agu, Hamilton, & Baker, 1999). Physical therapists should be aware of

which postoperative type 2 diabetic patients qualify for the use of compression therapy. Suggesting compression stockings to a patient with known peripheral neuropathy or peripheral vascular disease could cause further damage to the patient's lower leg circulation.

Regular wound checks should be performed to ensure that skin remains healthy and intact while the patient is in bed. The poor peripheral circulation caused by peripheral vascular disease puts type 2 diabetics at an increased risk for acquiring bedsores. Peripheral neuropathy can reduce the patient's sensation to the extremities making it difficult for them to feel wounds developing. For this reason, regular skin assessments should be performed by healthcare professionals. While this task typically falls upon nursing staff, physical therapists should take an active role in checking the extremities for signs of skin breakdown. Tutle et al. identifies seven areas on the foot that are at greatest risk for skin breakdown; these areas include the great toe, first, third and fifth metatarsal heads, the medial and lateral midfoot, and the heel (2012). Medial and lateral malleoli should also be inspected since these areas are points of contact when the patient is lying on either side. Assessments of the feet should include visual inspection as well as palpation. Visual examination of the feet should identify any redness or obvious areas of skin breakdown. Palpation of the feet is meant to identify the presence of heat or swelling as well as detects areas of pain upon contact (Tutle et al., 2012). Areas of concern should be documented to track the progression of possible skin breakdown. Proper assessment and documentation are necessary components in the prevention of pressure ulcers.

Pulmonary Complications

Pulmonary conditions such as pneumonia and respiratory infections are common complications in type 2 diabetic patients on bed rest. Decreased lung usage while the patient is

in bed can allow fluid to accumulate in the lungs. When combined with the increased risk of infections experienced by type 2 diabetics, resultant pulmonary complications arise.

Incentive spirometry is a commonly used strategy in the pulmonary management of postoperative patients (Crowe & Bradley, 1997). Incentive spirometry devices are designed to allow patients to practice deep breathing during partial of full bedrest. For optimal results, the incentive spirometers must be used on a regular basis. Crowe and Bradley report that patients should perform four to five maximal inhalations per hour during the waking hours (1997). The physical therapist's role is to promote proper deep breathing, not only through the use of incentive spirometry, but also during daily activity. Upon each session with the postoperative patient, the physical therapist should make sure that the incentive spirometer is within the patient's reach and that he or she is properly informed on how to use the device. Incentive spirometer usage should also be documented to better track the patient's compliance.

Ambulation

Patients that are able to ambulate out of bed should do so frequently. Extended periods of bed rest can cause additional harm. A muscle can lose 10-15% of its strength per week during complete bed rest, and nearly half of normal strength is lost within 3-5 weeks (Dittmer & Teasell, 1993). This is especially prominent in the muscles of the leg. Therefore, frequent ambulation should be promoted to maintain leg muscle strength and functionality. Ambulation and physical activity promote circulation to the lower extremities combatting the harmful effects of peripheral vascular disease. Increased postoperative walking decreases the risks of pulmonary disorders and deep vein thrombosis (Whitney & Parkman, 2004). Although early ambulation is recommended in postoperative patients, individuals with diabetes-related complications may experience difficulty in doing so. Many diabetic patients have concurrent conditions such as

obesity, lower limb pain, and sensory loss that cause them to fatigue quickly (Kluding et al., 2015). This may make initial ambulation difficult in the postoperative period. For this reason, physical therapists should play an active role in assisting with such ambulation. Although the responsibility of ambulating postoperative patients frequently falls upon the nursing staff, a physical therapist should be present at minimum during the patient's first time out of bed. This is to ensure that the patient is transferring safely out of and back into bed without risk of injury to themselves or others. Documentation should be kept to track the frequency and distance of each bout in order to monitor the patient's progression and promote continuity among caregivers.

Patients that are unable to ambulate for any reason should perform range of motion exercises in the supine or seated position. Despite the fact that range of motion exercises do not provide the weight bearing benefits that ambulation does, they promote circulation to the periphery and maintain neuromuscular functioning. More research is needed to create an effective range of motion exercise prescription for patients on prolonged bedrest.

Postoperative Exercise

Postoperative recovery extends beyond the patient's hospital stay. Physical activity should be maintained upon discharge of the hospital or rehab facility. Physical activity promotes proper insulin utilization and helps to maintain normal blood glucose levels (Kluding et al. 2015). This makes physical activity extremely important in the reduction of complications associated with type 2 diabetes. Until recently, weightbearing activity was not recommended in type 2 diabetic patients with peripheral neuropathy due to increased risk of ulceration (Tuttle et al., 2012). However many recent studies such as one published by Kluding et al., support claims that weight bearing activity in diabetic peripheral neuropathy patients does not increase rates of foot ulcers (2015). The study performed by Kluding et al. reported no serious adverse events

related to weight bearing activity in diabetic patients with peripheral neuropathy (2015). Weight bearing activity is an important aspect in maintaining bone health, mobility, and general fitness and therefore should be incorporated into the exercise prescription of type 2 diabetic patients including those with peripheral neuropathy (Tuttle et al., 2012).

Recommendations for physical activity in type 2 diabetics include a minimum of 150 minutes of moderate to vigorous activity per week (Lowery, 2010). This recommendation may be unrealistic in the immediate postoperative period. Initial exercise prescriptions in postoperative type 2 diabetics may need to be lower in intensity and/or frequency due to decreases in functional capacity. Patients who are not able to meet these recommendations should still aim for the highest activity level tolerated (Kluding et al., 2015). Physical therapists should prescribe exercise based on the functional capacity of each postoperative patient. Progression of exercise frequency and intensity should aim to increase mobility and functional capacity. Documentation of this progression is especially important to monitor the recovery of each patient.

Type 2 diabetic patients should be encouraged to monitor blood glucose levels before and after physical activity. During inpatient physical therapy, the low level of physical exertion is not usually enough to cause a drop in blood glucose levels; however in a setting where higher levels of physical activity are performed, it is important to measure blood glucose levels prior to exercise (K. Greibel, personal communication, November 6, 2015). While it is outside the scope of practice for a physical therapist to prescribe specific doses of insulin based on a patient's blood glucose level, physical therapists should actively encourage the patient to monitor their blood sugar before strenuous exercise. Exercise should be postponed until the patient's blood glucose level is within normal limits.

Conclusion

Physical therapists should play an active role in the prevention of postoperative complications in type 2 diabetic patients. Coordinated efforts between doctors, nursing staff, and physical therapists should be made to manage each patient's care. Although pharmacologic therapy and proper nutrition are key components in the reduction of postoperative complications, physical therapy should be emphasized to further reduce complications. Tactics including frequent repositioning, compression therapy, and regular skin assessments should be employed by the physical therapist to reduce a type 2 diabetic patient's risk of skin ulceration. Hourly incentive spirometry should be promoted in postoperative patients to improve lung functioning thereby reducing risks of pulmonary disorders. Physical therapists should promote early ambulation in diabetic surgical patients to increase blood flow to the distal tissues of the body. Postoperative exercise programs should be designed to allow type 2 diabetic patients to progress to their pre-surgical functional capacities as quickly and safely as possible. Such exercise programs should include weight bearing activities even if the patient has known peripheral neuropathy. All aspects of care should be documented thoroughly to increase continuity among healthcare workers and monitor patient status. While each patient requires an individualized plan of care, these guidelines should be met whenever possible. Implementation of a care-path driven by the guidelines stated could result in decreased rates of postoperative complications in type 2 diabetic patients. Reduction in postoperative complications can ultimately lower health care costs and improve patient quality of life.

References

Agu, O., Hamilton, G., & Baker, D. (1999). Graduated compression stockings in the prevention of venous thromboembolism. British Journal of Surgery, 86(8), 992-1004.

Bianchi, J., Mahoney, K., Nugent, L., & Keen, D. (2013). A fresh way to treat venous leg ulcers with measured compression. British Journal Of Community Nursing, 34-40.

Centers for Disease Control and Prevention. (2014) National diabetes statistics report: estimates of diabetes and its burden in the United States, 2014. Atlanta, GA: U.S. Department of Health and Human Services.

Chuah, L. L., Papamargaritis, D., Pillai, D., Krishnamoorthy, A., & Le Roux, C. W. (2013). Morbidity and mortality of diabetes with surgery. Nutricion Hospitalaria, 2847-52.

Clement S, Braithwaite SS, Magee MF et al (2004) Management of diabetes and hyperglycaemia in hospitals. Diabetes Care. 27(2), 553-591

Cullum, N., Nelson, E. A., Fletcher, A. W., & Sheldon, T. A. (2001). Compression for venous leg ulcers. The Cochrane Library.

Dagogo-Jack, S., Alberti, K. (2002) Management of diabetes mellitus in surgical patients. Diabetes Spectrum. 15(1) 44-48.

Dittmer, D. K., & Teasell, R. (1993). Complications of immobilization and bed rest. Part 1: musculoskeletal and cardiovascular complications. Canadian Family Physician, 39, 1428.

Holt, P. (2009) Diabetes in hospital: a practical approach for healthcare professionals. John Wiley & Sons.

Johnson, A. R., & Rogers, L. C. (2011). The venous leg ulcer complicated by diabetes. Podiatry Management, 30(6), 157-162 6p.

Kluding, P. M., Pasnoor, M., Singh, R., D'Silva, L. J., Min, Y., Billinger, S. A., & ... Wright, D. E. (2015). Safety of aerobic exercise in people with diabetic peripheral neuropathy: single-group clinical trial. physical therapy, 95(2), 223. doi:10.2522/ptj.20140108

Metchick, L.N., Petit, W.A., Inzucchi, S.E. (2002) Inpatient management of diabetes mellitus. American Journal of Medicine. 113(4), 317-323.

Morrison, S., O'Donnell, J., Dianxu, R., & Henker, R. (2014). Perioperative glucose monitoring and treatment of patients undergoing vascular surgery in a community hospital setting. AANA Journal, 82(6), 427-430.

LeMaster, J. W., Mueller, M. J., Reiber, G. E., Mehr, D. R., Madsen, R. W., & Conn, V. S. (2008). Effect of weight-bearing activity on foot ulcer incidence in people with diabetic peripheral neuropathy: feet first randomized controlled trial. Physical Therapy, 88(11), 1385.

Lovecchio F, Beal M, Kwasny M, Manning D. (2014). Do patients with insulin-dependent and noninsulin-dependent diabetes have different risks for complications after arthroplasty?. Clinical Orthopedics and Related Research, 472(11), 3570-3575.

Lowery, F. (2010). New guidelines for exercise in type 2 diabetes. Medicine and Science of Sports and Exercise, 42.

Tuttle, L. J., Hastings, M. K., & Mueller, M. J. (2012). A moderate-intensity weight-bearing exercise program for a person with type 2 diabetes and peripheral neuropathy. Physical Therapy, 92(1), 133. doi:10.2522/ptj.20110048

Whitney, J. D., & Parkman, S. (2004). The effect of early postoperative physical activity on tissue oxygen and wound healing. Biological Research for Nursing, 6(2), 79-89.

Zantidis, A., Iliadis, F., Didangelos, T. (2011) Insulin therapy during hospitalization. Diabetes Research and Clinical Practice. 93, S78-S85.

Appendix A

Physical Therapy Interview

Two practicing physical therapists were interviewed to gain insight as to what is currently being done to manage type 2 diabetic complications. Exact transcripts of the interviews are included.

Katherine S. Griebel, PT, DPT

1. How prevalent is type 2 diabetes among the patients that you treat?

I don't know exact numbers or statistics off the top of my head, but diabetes seems to be quite common in the population of patients I see. I work in a skilled nursing unit of a hospital, so most of the patients I work with are older (>60 y/o) and have multiple complex comorbidities. Diabetes is often one of those comorbidities that make recovery slightly more complicated.

2. Are patients with no known diabetic history screened for diabetic risk factors? If so, what risk factors would be need present for you to refer the patient to their primary care physician for further screening?

I honestly don't know if doctors or nurses screen for diabetes when a patient is admitted to our unit. As a PT, I do not screen for risk factors, but I do screen for complications.

3. Are patients with known type 2 diabetes screened for any signs or symptoms associated with diabetic complications (i.e. peripheral neuropathy, retinopathy, etc.)?

I always do a screen for sensation to light touch during evaluation to test for peripheral neuropathy. In my experience, patients with impaired sensation know that their neuropathy is caused by some underlying issue such as diabetes, or history of stroke, or any other disease or condition that affects sensation. However, if I find a patient who has impaired sensation and this is a new finding, or they say they don't have a history of diabetes, then I will refer to a physician. In my setting at the skilled nursing facility, I would make sure the physician in my unit is aware of my finding, and let them communicate with the patient's primary care physician. If I were working outpatient, I'd report to the referring physician, or if the patient is utilizing direct access and did not have a referring physician, I'd notify the primary care physician.

4. Is blood glucose monitoring performed or encouraged prior to performing exercise in patients with type 2 diabetes? If so, what course of action is taken if the patient's blood glucose level is deemed unacceptable for exercise?

Yes. My only work experience as a PT has been in a hospital setting, where the nursing staff monitors blood glucose before meals. Checking blood sugar before exercise is not as essential in this setting because the level of exertion is usually not intense enough to cause a sudden drop in blood glucose. In a setting where the therapeutic session is going to require higher levels of exertion, such as outpatient, it is important to check blood sugar before exercise. In any setting, if blood glucose is unacceptable for exercise, we stop the exercise until it stabilizes.

5. Is examining for wounds or ulcers performed or encouraged in patients with type 2 diabetes? If so, what course of action is taken upon finding a wound or ulcer?

Yes. In the hospital where I work, nurses do the wound care, so any ulcers or wounds I find, I report to the patient's nurse. This course of action is facility-dependent. In some hospitals, PT's do wound care so the protocol would differ.

6. How does the presence of type 2 diabetes affect initial exercise prescription?

It does not affect the way I initiate exercise in my patient population. Like I said before, the level of intensity of exercise in my setting is usually mild, and the patient's blood sugar is usually very well controlled. I expect this answer would be very different for a PT working in an outpatient setting, where exercise is generally more intense, and blood sugar more variable.

7. In what ways are diabetic complications (i.e. peripheral neuropathy, blood glucose level, retinopathy, etc.) managed in an exercise setting?

When I work with a patient with peripheral neuropathy, I try to make sure he has shoes on during therapy. In the hospital, patients often come to therapy wearing their non-skid socks, but in a patient known to have impaired sensation, I try to get shoes on him to keep their feet safer during a therapy session. If a diabetic patient tells me that he's feeling dizzy, weak, or shaky, I start with checking vital signs. If these are normal, I usually give him juice and contact his nurse to check blood sugar. If I am unsure if a patient is reporting these symptoms due to low

or high blood sugar, I always give something to raise blood sugar. Having too-high blood sugar is not as dangerous as having a too-low level.

Amethyst Barto, PT, DPT

1. How prevalent is type 2 diabetes among the patients that you treat?

Quite prevalent, I would say almost 40% of my case load.

2. Are patients with no known diabetic history screened for diabetic risk factors? If so, what risk factors would be need present for you to refer the patient to their primary care physician for further screening?

Not necessarily every patient is screened. When risk factors present themselves, I would then refer to MD for possible diabetic screening. The risk factors that would cause me to speak with a patient would include polydipsia, polyphagia, consistent feeling of being light headed during exercise of position changes. If these issues presented themselves, I would ask the patient about his or her diet that day and possibly suggest going to see a MD as well as educating the patient on what to and not to consume prior to PT sessions.

3. Are patients with known type 2 diabetes screened for any signs or symptoms associated with diabetic complications (i.e. peripheral neuropathy, retinopathy, etc.)?

Absolutely. At our clinic, we see a lot of patients with nerve pain, many with a history of type 2 diabetes mellitus. At that point, we need to determine whether it is from diabetic

neuropathy vs peripheral nerve injury vs a more central cause. That is probably the most common.

4. Is blood glucose monitoring performed or encouraged prior to performing exercise in patients with type 2 diabetes? If so, what course of action is taken if the patient's blood glucose level is deemed unacceptable for exercise?

Typically, my patients are very compliant with managing their diabetes and test/adjust what they need prior to coming into the clinic. However, we do keep orange juice on hand for patients with episodes of hypoglycemia as well as educate patients on bringing any other medications (any sort of insulin or the like) which may be needed in any hyperglycemic event. I have yet to have a patient with a dangerous blood glucose level prior, during or after exercise.

5. Is examining for wounds or ulcers performed or encouraged in patients with type 2 diabetes? If so, what course of action is taken upon finding a wound or ulcer?

Both performed and encouraged. Like I stated before, we do see a lot of nerve pain and numbness in extremities. If this is persistent we then take the time to educate on performing daily self-checks. Again, my patients thus far have managed their diabetes well and are compliant with self-checks that I have yet to find a wound or ulcer.

6. How does the presence of type 2 diabetes affect initial exercise prescription?

Initially, I discuss with the patient scheduling PT around the times that are best for them regarding blood glucose. I tend to be on the more cautious side with initial exercise prescription so I begin with very simple, low resistance, low repetition exercises until I see how the patient responds. Most patients with history of type 2 diabetes mellitus do well with a gradual start and gradual progression.

7. In what ways are diabetic complications (i.e. peripheral neuropathy, blood glucose level, retinopathy, etc.) managed in an exercise setting?

I find many times when patients tell me they have "diabetic neuropathy" and any nerve pain or numbness in bilateral lower extremities it can be managed by many of the techniques we perform in our clinic, though most are manual based. I also help to manage complications associated with peripheral neuropathy (falls, gait deviations) with gait training, neuromuscular reeducation and balance training by strengthening the other systems throughout their body which are intact, despite the loss in sensation. Same goes for retinopathy. Regarding exercise, I do have patients who have been able to manage an improved blood glucose level with less medication intake with a gradually introduced cardiovascular and resistance program which they can perform both in the clinic and for a home exercise program.